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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
A61F 2/32

A1

(11) International Publication Number: WO 98/55050

(43) International Publication Date: 10 December 1998 (10.12.98)

(21) International Application Number: PCT/US98/11682

(22) International Filing Date: 4 June 1998 (04.06.98)

(30) Priority Data:
870,186 6 June 1997 (06.06.97) US

(71) Applicant: NEW YORK SOCIETY FOR THE RELIEF OF THE RUPTURED AND CRIPPLED MAINTAINING THE HOSPITAL FOR SPECIAL SURGERY [US/US]; 535 East 70 Street, New York, NY 10021 (US).

(72) Inventor: LIPMAN, Joseph, David; 531 East 72 Street, New York, NY 10021 (US).

(74) Agents: SWEEDLER, Michael, J. et al.; Darby & Darby P.C., 805 Third Avenue, New York, NY 10022–7513 (US).

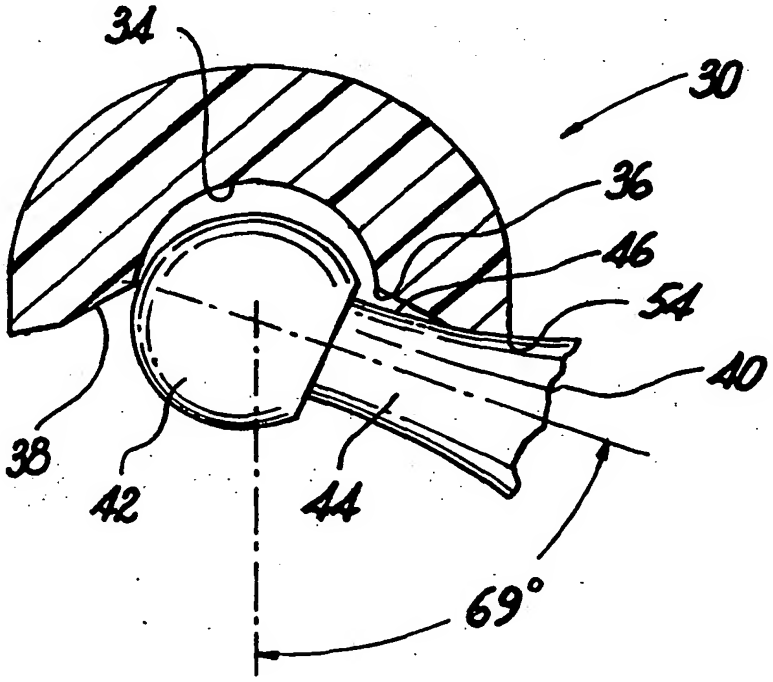
(81) Designated States: AU, CA, JP, KR, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: HIP REPLACEMENT

(57) Abstract

This invention is a hip replacement prosthesis for reducing the likelihood of joint dislocation, including a femoral component (40) having a head (42), an elongated neck (44) and an acetabular cup (32) formed with a socket to capture the head. The socket includes a formed annular liner (36) defining a stop to engage the neck during extreme motion. The neck contact surface and annular liner cooperate to shift the resultant contact point radially outwardly from the head to minimize dislocation resulting from the moment acting upon the femoral component.



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HIP REPLACEMENT

Field of the Invention

The invention relates to prostheses, and more particularly an acetabular cup and femoral component configured for a hip replacement system to reduce the likelihood of dislocation during flexing of the joint.

Background of the Invention

Artificial joints provide patients having arthritic or otherwise dysfunctional skeletal features with an alternative treatment for the chronic pain and discomfort often associated with such problems. Correction of the condition generally involves surgically replacing one or more of the natural components making up the joint with an artificial equivalent.

One of the more widely implemented artificial joints serves as a substitute for hips. A typical hip replacement system generally includes a femoral prosthesis implanted in the upper end of the femur when the femoral head requires replacement. The replacement is formed with a spherically shaped head and an elongated narrow neck extending from the head for attachment to the femur. The femoral head is complementally formed to pivotally nest within the socket of an acetabular cup. The cup includes a hemispherical base for mounting to the pelvis, and an outwardly opening socket to receive the femoral head. The prosthesis components are generally implanted during a surgical procedure well known to those skilled in the art.

While the typical hip replacement system described above provides a moderate range of mobility, the acetabular cup generally has limited clearance with respect to the neck

of the femoral prosthesis. As a result, attempts by the patient to forcefully move the joint beyond the designed range of motion may cause the femoral head to pop out of the cup, resulting in dislocation that ultimately may require subsequent surgery for correction.

One attempt to expand the range of movement is disclosed in U.S. Patent No. 5,387,244. The joint includes an acetabular cup with a bevelled edge for anchoring to the pelvis and a femoral prosthesis configured with a spherical head and a neck formed in lateral offset relation away from the medial side to the longitudinal axis of the femoral prosthesis. The neck includes a formed contact surface to complementally engage the bevelled edge of the cup to define a maximum degree of flexion.

While the design above may provide a relatively moderate range of mobility, the problem of dislocation remains unresolved. Dislocation typically occurs when the neck of the femoral component contacts the acetabular liner and rotates about that contact point. For the modified hip replacement system described above, the resultant contact point defined by the beveled edge and the contact surface occurs near the head center to create a fixed fulcrum that cooperates with the bulk of the prosthesis length to generate a relatively large moment. Under some circumstances, this moment is capable of dislodging or dislocating the head out of the cup. Moreover, continuous impact between these components can cause wear debris to accumulate in the joint.

Therefore, the need exists for a hip replacement system configured to minimize the occurrence of dislocation of the femoral component and the cup. Moreover, the need also exists for such a system to provide an expanded range of motion for the connected joint. The hip replacement of the present invention satisfies these needs.

SUMMARY OF THE INVENTION

The hip replacement of the present invention provides patients the capability of carrying out everyday

tasks with the reduced likelihood of component dislocation. This minimizes the complications and expense arising from reassembling the joint through subsequent surgery or the like. It also reduces the accumulation of wear debris caused by impacts between the hip components. Additionally, the design of the hip replacement expands the range of flexion for the joint to correspondingly create a wider range of mobility for the patient.

To realize the advantages described above, the present invention, in one form, comprises an acetabular cup for mating to a femoral component comprising a ball-shaped head and a reduced-diameter neck, i.e. a neck having a diameter less than the diameter of the head. The component neck extends axially from the head and has a contact surface. The cup includes a socket adapted to pivotally capture and secure the femoral component head. The socket is bounded peripherally by an engagement surface to define a stop for engaging the contact surface to establish an initial contact point corresponding to a predetermined motion limit. As the hip joint moves beyond this motion limit, the contact point shifts radially outwardly along the surface to reduce the likelihood of dislocation.

Other features and advantages of the present invention will be apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a lateral sectional view of a conventional hip replacement system;

FIG. 2 is a view similar to Fig. 1 showing a maximum degree of deflection before dislocation;

FIG. 3 is a lateral sectional view of the present invention according to a first embodiment;

FIG. 4 is a view similar to Fig. 3;

FIG. 5 is a lateral sectional view of the present invention according to a second embodiment; and

FIG. 6 is a view similar to Fig. 5.

DETAILED DESCRIPTION OF THE INVENTION

A human hip joint typically comprises a socket portion formed in the pelvis to rotatably capture a ball-shaped head portion projecting inwardly from the femur bone. Severe dysfunction of the joint often requires hip arthroplasty, involving a surgical substitution of the socket portion, the head portion, or both.

Referring now to Figures 1 and 2, a conventional hip replacement system for substituting a human hip joint, generally designated 10, includes an acetabular cup 12 and a femoral element 18. The acetabular cup is configured with a curved (for example, hemispherical) shape and is formed with a central cavity 14 (Figure 2) that opens radially outwardly to define a socket. The socket is bounded radially by a chamfered anterior rim 16 that extends radially outwardly to define a flat liner. During the arthroplasty procedure, the cup is typically implanted in the pelvis.

Further referring to Figures 1 and 2, the femoral component 18 is typically implanted into the femur bone and includes a formed mushroom shaped head 20 for rotatably nesting in the cup socket 14. Projecting axially outwardly from the head is a formed neck that angles radially outwardly to define a shaft 22. The neck forms an engagement surface for impinging the radial contact edge during extreme movement of the joint.

Dislocation of the components comprising a conventional hip replacement system typically results from an overabundance of leverage caused by extreme movement. Figure 1 illustrates the cup 12 and the femoral element 18 oriented with the neck initially impinging on the anterior rim, but with the head 20 still securely nested in the socket 14. Continued flexure of the joint beyond the orientation shown in Figure 1 results in the head popping out of the socket, as shown in Figure 2, due to the fixed leverage created at the constant contact point.

Referring now to Figures 3 and 4, the hip replacement system of the present invention, according to a first embodiment, and generally designated 30, avoids the

dislocation problem described above by providing an acetabular cup 32 that cooperates with a femoral component 40 to establish decreasing leverage on the femoral component during extreme movement of the joint.

With continuing reference to Figure 3, the acetabular cup 32 may be substantially crescent shaped in cross-section, with a centrally formed cavity 34 (Figure 4) defining a hemispherical socket (for example) and bounded radially by an anterior rim 36. The rim extends radially outwardly at an angled orientation to form a convex liner 38 defining a stop.

The femoral component 40, which may be the same as the femoral component shown in Figs. 1 and 2, comprises a ball-shaped head 42 and a reduced-in-diameter neck 44 extending axially from the head and having a formed contact surface 46.

During an arthroplasty procedure, the acetabular cup 32 is implanted into the pelvis (not shown), while the femoral component 40 is implanted into a surgically modified femur bone (not shown). Following the surgical procedure, the joint is fully operative to allow relative rotation between the two components.

As shown in Figure 3, operation of the hip replacement 30 will often involve movement to an orientation such that the contact surface 46 of the neck 44 abuts the liner 38 at an initial contact point 50 corresponding to a predetermined motion limit. The initial contact orientation, according to a first embodiment, comprises 57 degrees of deflection as compared to a socket central axis 52. Further flexing of the joint places an increasing load on the femoral component resulting from leverage being exerted at the initial contact point.

However, as shown in Figure 4, due to the unique declining angular convex configuration of the liner 38, as the hip joint moves beyond this motion limit, the contact point shifts radially outwardly along the liner to a peripheral contact point 54 allowing a maximum deflection of 69 degrees, while reducing the dislocation leverage acting

on the femoral component. Additionally, by decreasing the dislocation leverage acting on the femoral component, an oppositely directed correction leverage is increased to maintain the component within the socket.

Referring now to Figure 5, a second embodiment of the present invention, generally designated 60, implements an acetabular cup 62 formed substantially similar to that of the first embodiment, but having a less pronounced angular decline for the convex liner 64. A femoral component 66 is also included which is formed substantially similar to that of the first embodiment.

It has been discovered that by making the angle of decline less pronounced for the liner 64 with respect to the angle implemented for the liner according to a first embodiment of the present invention, during operation, the contact point shifts radially outwardly, while allowing an unexpected advantage in relative mobility from 69 degrees to 73 degrees.

In the illustrated embodiments, the liner 38 is convex and the contact surface 46 of neck 44 concave. Other shapes for these surfaces are also contemplated. For example, the surface 38 may be curved and the surface 46 straight, i.e. not curved in cross section, or surface 46 may be curved and surface 38 straight. Possibly, surface 38 may be concave and surface 46 convex. The invention contemplates any surface configurations which enable the contact point between the neck and the liner to move outwardly or toward the periphery of the liner as motion of the femoral component increases.

It is also envisioned that the present invention may be individually packaged and sold as a kit of unassembled components to reduce any unnecessary costs associated with purchasing an entire system, should only the need for one component of the system arise.

Those skilled in the art will appreciate the many benefits and advantages realized by the present invention. Of paramount importance is the shifting contact point feature that minimizes leverage acting upon the femoral

component to pop it from the cup socket. As a direct result, severe dislocations that may degrade the performance of the joint are substantially reduced. Moreover, by greatly reducing the number of dislocations between the hip joint components, subsequent costly surgical corrections are dramatically minimized.

While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. An acetabular cup for implanting within a pelvis and mating to a femoral component, said femoral component comprising a ball-shaped head and a reduced-diameter neck extending axially from the head and having a contact surface, said cup including:

a socket adapted to pivotally capture and secure said femoral component head, said socket bounded peripherally by a liner to define a stop for engaging said contact surface and establishing an initial contact point corresponding to a predetermined motion limit between said femoral component and said cup, said contact surface and liner operable, when assembled, as said hip joint moves beyond said motion limit to cooperatively shift said contact point radially outwardly along said liner to prevent dislocation.

2. An acetabular cup according to claim 1 wherein said liner is generally hemispherical and formed with an inwardly angled convex surface of a predetermined curvature.

3. A replacement hip system including:

a femoral component comprising a ball-shaped head and a reduced-in-diameter neck extending axially from said head and having a contact surface; and

an acetabular cup formed with a hemispherically formed socket to pivotally capture and secure said head, said socket bounded peripherally by a liner defining a stop for engaging said contact surface and establishing an initial contact point corresponding to a predetermined motion limit, said contact surface and liner operable, as said hip joint moves beyond said motion limit to cooperatively shift said contact point radially outwardly along said liner to prevent dislocation.

4. A replacement hip system according to claim 3 wherein:

said contact surface is formed with a predetermined concave curvature; and

said annular liner is formed with a predetermined convex curvature.

5. A replacement hip system according to claim 3 wherein:

said contact surface is formed with a predetermined convex curvature; and

said annular liner is formed with a predetermined concave curvature.

6. A replacement hip system according to claim 3 wherein said femoral component is formed substantially symmetrically about a central longitudinal axis.

7. A hip replacement kit including:

a femoral component comprising a ball-shaped head and a reduced-in-diameter neck extending axially from said head and having a contact surface; and

an acetabular cup adapted for assembly to said femoral component, said cup formed with a hemispherically formed socket to pivotally capture and secure said head, said socket bounded peripherally by a liner defining a stop for engaging said contact surface and establishing an initial contact point corresponding to a predetermined motion limit, said contact surface and liner operable, when assembled, as said hip joint moves beyond said motion limit, to cooperatively shift said contact point radially outwardly along said liner to prevent dislocation.

8. A method of reducing the likelihood of dislocation in a hip replacement having a femoral component comprising a spherical head and an attached neck, and an acetabular cup formed with a socket for receiving the

component head and bounded by an annular liner, said method including the steps of:

establishing an initial contact point between said femoral component neck and said liner corresponding to a predetermined motion limit; and

shifting said contact point radially outwardly along said liner in response to increasing movement beyond said predetermined motion limit.

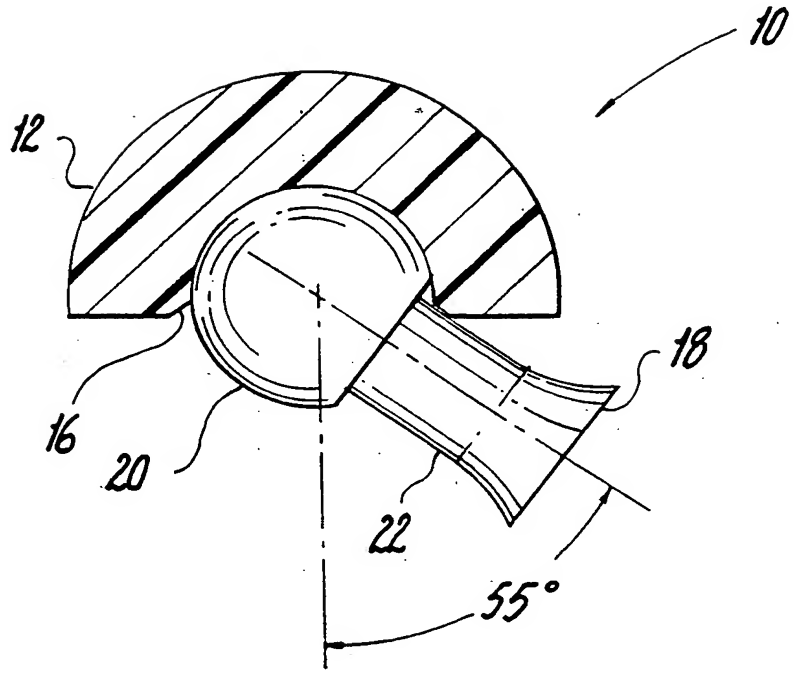

Fig. 1
(Prior Art)

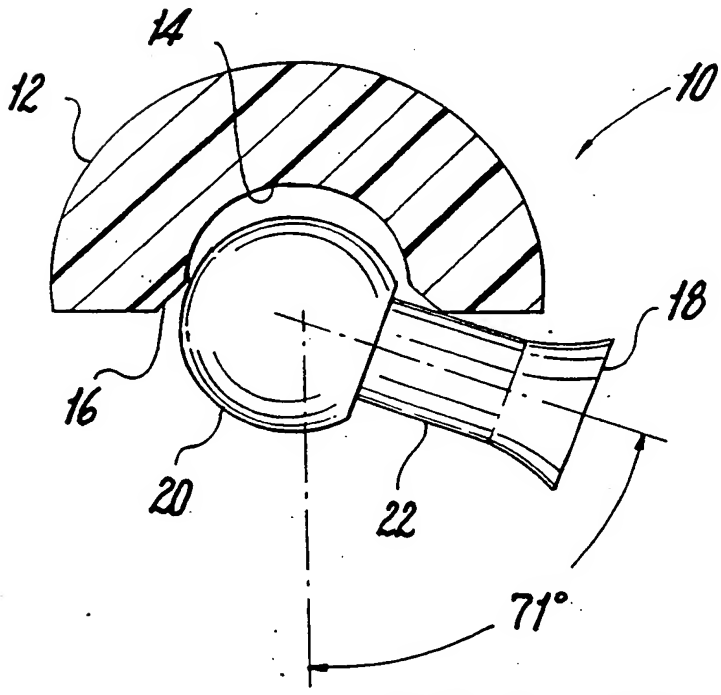

Fig. 2
(Prior Art)

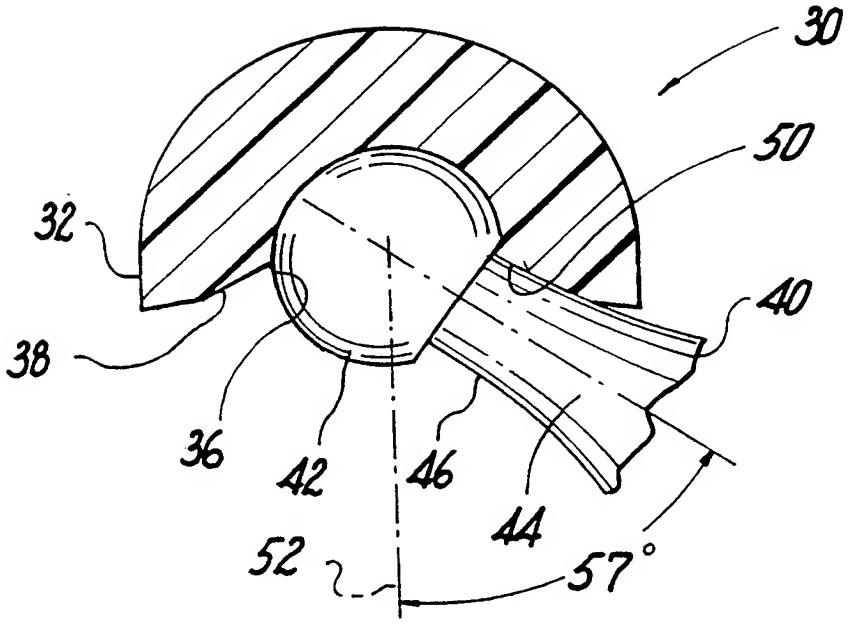

Fig. 3

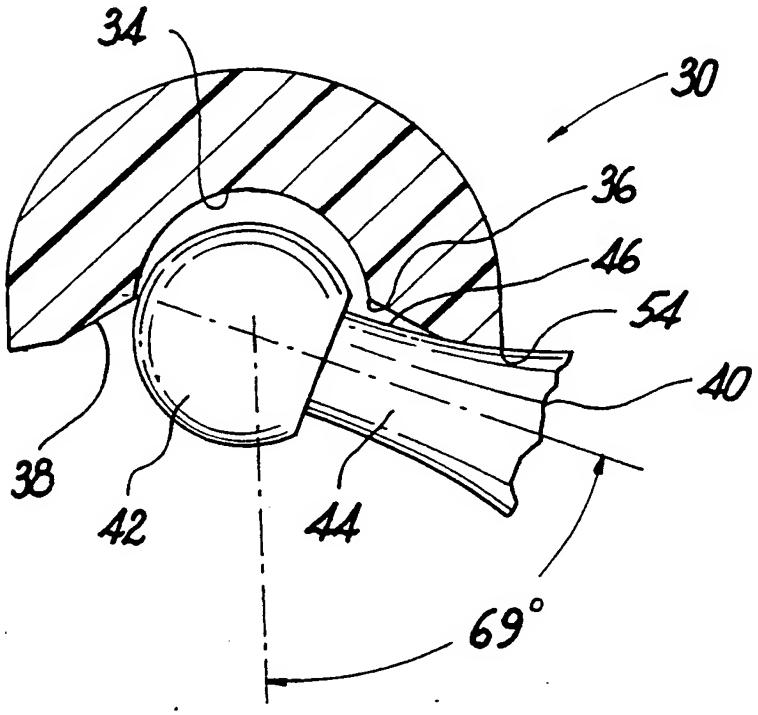

Fig. 4

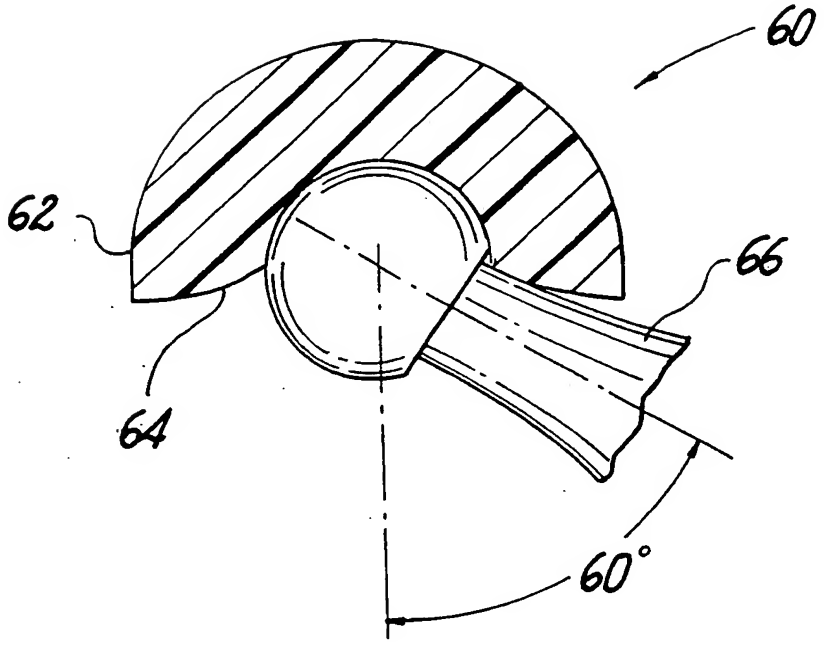

Fig. 5

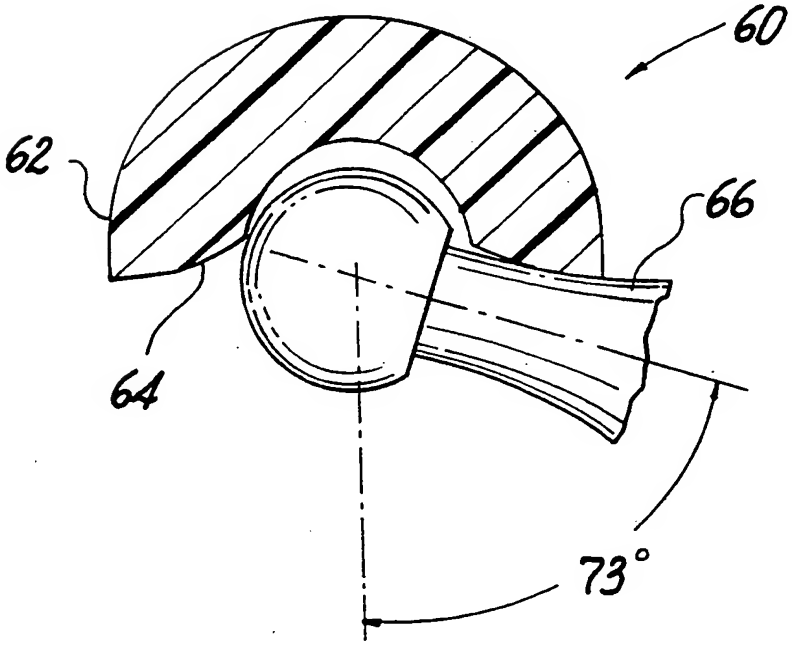

Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/11682

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61F 2/32
US CL :623/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 623/18, 22, 23

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3,924,275 A (HEIMKE et al) 09 December 1975, Fig. 1 showing an acetabular cup havng a continuous convex rim; Figs. 7-9 showing a femoral component having a reduced diameter neck which contacts a contact point that shifts radially outward along the rim.	1-5, 7, 8
X	SU 1711867 A (BERDYEV) 15 February 1992, Fig. 1.	1-8

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search

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Date of mailing of the international search report

22 JUL 1998

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Authorized officer

BRUCE SNOW

Telephone No. (703) 308-3255

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